الطحالب العملي

Practical phycology

المرحلة الثانية

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Lab. 1

Algae forms

1. **Unicellular form.**
   - **a- Motile ---------- ex: Euglena , Chlamydomonas**
   - **b- Non-motile---------ex: Gloeocapsa .**

2. **Colonial form.**
   - **a- Coenobium------ motile ex: Volvox**
     Non-motile ex: Pediastrum, Scendesmus
   - **b- Aggregate -------- ex: Microcystis , Merismopedia.**

3. **Filamentous form:**
   - **a- Simple filament--------- ex: Ulothrix , Oedogonium.**
   - **b- Branched filament**
     -Trully branched---------- ex: Cladophora , Pithophora.
     - False branched----------ex: Scytonema.

4. **Siphonous form:**

   Ex: Vaucheria

5. **Tubular form**

   Ex: Enteromorpha

6. **Membranous form (parencymatous form)**

   Ex: Ulva

7. **Thallus form:**

   Ex: Chara , Nitella

Shape of plastids

Chloroplast:

A plastid containing chlorophyll, developed only in cells exposed to the light. Chloroplasts are minute flattened granules, usually occurring in great numbers in the cytoplasm near the cell wall, and consist of a colorless ground substance saturated with chlorophyll pigments. Under light of varying intensity they exhibit phototactic movements. In animals chloroplasts occur only in certain low forms.

1. **Cup shape chloroplast ------ ex: Chlamydomonas**
2. **Gridle shape chloroplast----- ex: Ulothrix**
3. **Discoid shape chromoplast---- ex: Vaucheria**
4. **Reticulate shape chloroplast---- ex: Oedogonium**
5. **Spiral shape chloroplast ----------ex: Spirogyra**
6. **Stellate shape chloroplast---------ex: Zygnema**
7. **Parietal shape chl.-------- ex: Scendesmus , Pediastrum**
8. **Twisted shape chl. -------- ex: Mougeotia**

Lab 2

Properties of Major Algal Taxonomic Groups

Algae are an extremely diverse group of organisms. The classification of algae is dependent upon several factors including: size, habitat, morphology, reproduction, pigments, physiology, and biochemistry. The most prominent phyla of algae are the Chlorophyta (green algae), Heterokontophyta Class Phaeophyta, the (brown algae), and the Rhodophyta (red algae).

1. Photosynthetic pigments.
2. The storage products.
3. Cell wall structure.
4. flagellar apparatus
5. organelle structure and function

no	Taxonomic Group	Chlorophyll	Carotenoids	Storage products	Flagellation &Cell structure
1.	**Bacillariophyta**	**a, c**	**β-carotene** **± -carotene rarely fucoxanthin,.**	**Chrysolaminarin** **oils**	**1apical flagellum in male gametes:** **cell in two halves with elaborate** **Markings.**
2.	**Chlorophycophyta** **(green algae)**	**a, b**	**β-carotene,** **± -carotene** **rarely carotene** **and**	**Starch, oils**	**1,2,4 to many,** **equal, apical or** **subapical flagella.**

			lycopene,lutein.		
3.	**Chrysophycophyta (golden algae)**	**a, c ,**	**β-carotene, fucoxanthin**	**Chrysolaminarin oils**	**1 or 2 unequal, apical flagella, in some, cell surface covered by characteristic scales.**
4.	**Cyanobacteria (blue green algae)**	**a,c**	**β-carotene, phycobilins**		
5.	**Phaeco phycophyta (brown algae)**	**a,c**	**β-carotene, ± fucoxanthin, violaxanthin**	**Laminarin, soluble carbohydrates, oils**	**2 lateral flagella**
6.	**Dinophyta (dinpflagellates)**	**a,c**	**β-carotene, peridinin, neoperididnin dinoxanthin, neodinoxanthin.**	**Starch, oils**	**2 lateral, 1 trailing,1 girdling flagellum, in most, there is a longitudinal and transverse Furrow and angular plates.**
7.	**Rhodo phycophyta**	**a, rarely d**	**β-carotene, zeaxanthin**	**Floridean starch oils**	**Flagella absent**

	(red algae)		**± β carotene**		

Methods of collecting algal samples:

- Benthic algae, Epiphytic, Epilethic and Epipelic ; samples collected either by hand, scalpel or by mud collecting apparatus.
- Plankton: the samples are collect by using the plankton net or van Dorn apparatus.
- Macro-algae grow either on a solid substrate or free-floating in water. In the former case it is necessary to cut the algae, that slightly rises the energy consumption. With free-floating algae, harvesting can be made by simply rising a net installed in the pond, with a large energy saving with respect to micro-algae, which need filtration for their separation.

Lab 3

Concentration methods:

1. **Centrifugation:** it is a method of separating algae from the medium by using a centrifuge to cause the algae to settle to the bottom of a flask or tank. This process occurs at 1000-1500 r/min for 10-20 min; collect the precipitate in preserve bottles and labeled with the information of date and place of sample.
2. **Filtration:** it is carried out commonly on membranes of modified Cellulose with the aid of a suction pump. The greatest advantage of this method as a concentrating device is that it is able to collect Microalgae or cells of very low density. However, concentration by filtration is limited to small volumes and leads to the eventual clogging of the filter by the packed cells when vacuum is applied.

3. **Precipitation:** is carried out by taking about 500-1000 cm^3 of algae sample in measuring cylinder, adding about 5-10 cm^3 of lugol solution. Settled for 10 days, and then remove the supernatant gently by pipette.

4. **Flotation:** Usually flotation is used in combination with flocculation for Algae Harvesting in waste water. It is a simple method by which algae can be made to float on the surface of the medium and removed as scum.

5. **Flocculation**

   It is a method of separating algae from the medium by using chemicals to force the algae to form lumps. The main disadvantage of this separation method is the additional chemicals are difficult to remove from the separated algae, probably making it inefficient uneconomic for commercial use, though it may be practical for personal use. The cost to remove these chemicals may be too expensive to be commercially viable.

Preservation methods

The most important preservation solutions for algae are:

1. Formalin (2-4) % with distilled water but not used with delicate algae.
2. Lugol solution composed of 10g of iodine, 20 g of potassium iodide dissolved in 200 ml of D.W the added 20g of glacial acetic acid before 2-3 days from used.
3. Solution composed of (formalin+acetic acid+ ethanol). It's an efficient solution with cytological studies and pigmentation , it's composed of dissolved 5ml of acetic acid in 50 ml of formalin and 10 ml of ethanol completed volume by added 35ml of D.W.

Preparation of slide:

- Microalgae are settled, and to a limited extent preserved, by the settling agent.

- Place a drop of the concentrated sample on each stage of the haemocytometer slide and gently slide the coverslip into place.
- Examine under the microscope first at low power then the high power (4ox).
- For examine the diatoms first clean the sample gently to distinguish the cell wall and the inner structures.
- The cleaning occurred by 15% of HCl or NaOH, transfer small amount of sample by glass transfer pipette over clean slide then applied to hotplate for several seconds ,add drop of water or glycerin 5% and examine under microscope.

Lab 4

Kigdom :monera

Division : Cyanophyta (Blue – green algae)

Class : Cyanophyceae

1- **Order** : Chroococcales

Family : Chroococcaceae

Genus : *Gloeocapsa*, *Chrooco, Merismopodia*

2- **Order** : Nostocales

Family : Oscillatoraceae A-

Genus : *Oscillatoria*

B- **Family** : Rivulariaceae

Genus : *Rivularia, Gloetrichia*

C- **Family** : Nostocaceae

Genus : *Nostoc* , *Anabaena*

D- **Family** : Scytonemataceae

Genus : *Scytonema*

Division : Cyanophyta

The cyanobacteria or blue-green algae form a natural group by virtue of being the only prokaryotic algae.

Class : Cyanophyceae

1-The Cyanophyceae or **blue-green algae** are usually referred to as the **cyanobacteria** (blue-green bacteria).

2- Morphology : The simplest morphology in the cyanobacteria is that of unicells, free-living.

3- Pigments and photosynthesis : The major components of the photosynthetic light harvesting system of the cyanobacteria are : chlorophyll **a ,** B-carotene, Myxoxantin ,biloprotein ,phycocyanin , phycoerythrin , Ailophycocyanin .

4- food storage in this phylum is cyanophycin .

1-Order : Chroococcales

single cells or cells loosely bound into gelatinous irregular colonies . This order included basically unicellular cyano-bacteria which are held together in palmelloid colonies by mucilage.

Chroococcus : Unicellular - colonial; colonies usually microscopic, only few-celled, more or less spherical, rarely many-celled, forming macroscopic, gelatinous mats; colonial slime fine, diffluent, homogeneous and colourless or lamellated , limited and (rarely) coloured; around gathered cells special own envelopes, usually copying the shape of cells, homogeneous or lamellated (up to rich lamellated).

Gloeocapsa : may be unicellular or made up of small groups of cells grouped within concentric mucilage envelopes.

Merismopedia : It is ovoid or spherical in shape and are arranged in rows and flats, forming rectangular colonies held together by a mucilaginous matrix. Species in this genus divide in only two directions, creating a characteristic grid-like pattern.

2-Order : Nostocales

This sub group is distinguished from all other cyanobacteria as filamentous organism , having the potential to produce heterocystis . heterocyatsis differentiation occures only when ammonium (or nitrate) nitrogen concentration is low in the medium (nitrogen fixation).

A- Family : Oscillatoraceae

Genus : ***Oscillatoria***

1- ***Oscillatoria*** is a genus of filamentous cyanobacteria which is named for the oscillation in its movement.

2- Filaments in the colonies can slide back and forth against each other until the whole mass is reoriented to its light source. It is commonly found in watering-troughs waters, and is mainly blue-green or brown-green.

3-*Oscillatoria* is an organism that reproduces by fragmentation. ***Oscillatoria*** forms long filaments of cells which can break into fragments called hormogonia. The hormogonia can grow into a new, longer filament. Breaks in the filament usually occur where dead cells(necridia) are present.

4-*Oscillatoria* uses photosynthesis to survive and reproduce.

B- **Family** : Rivulariaceae

Genus : ***Rivularia***, ***Gloetrichia***

Rivularia found as radial colonies , heterocystis is usually basal , gelatinous sheath surrounded all the filament. while in ***Gloetrichia*** found as radial

colony , heterocystis is usually basal , having akinete cell near heterocystis ,gelatinous sheath surrounded akinete cell and heterocystis only.

C- Family : Nostocaceae

Genus : ***Nostoc***, ***Anabaena***

All vegetative cells normally divide , ***Nostoc*** found as gelatinous colony , and the cells is ball-shaped (spherical) , heterocystis is intercalary. ***Anabaena*** found as filamentous form , heterocystis is terminal or intercalary.

D- **Family** : Scytonemataceae

Genus : ***Scytonema***

Scytonema found as false branched filament ,heterocystis are frequently located intercalary heterocystis, gelatinous sheath is thick and colored.

Lab 5

D : Chlorophyta

I – Cl : Chlorophyceae (green-algae)

1- O : Chlorellales (non-motile)

a- F : Chlorellaceae **ex**: *Chlorella*

b- F : Dictyoshaeriaceae **ex** : *Dictyosphaerium*

c- F : Scendesmaceae **ex** : *Scendesmus*

d- F : Hydrodictyaceae **ex** : *Hydrodictyon*

Pediastrum

2- O : Volvocales (motile)

a- F : Volvocaceae **ex**: *Volvox* , *Pandorina* , *Eudorina*

b- F : Chlamydomonadaceae **ex** : *Chlamydomonas*

3- O : Ulothricales

a- F : Ulothricaceae **ex** :*Ulothrix*

Chlorophyta :

1-The Chlorophyta or green-algae have a chlorophyll a , b and B-carotein , xanthphylls , differ from the euokaryotic algae in forming the storage product in the chloroplast instead of in the cytoplasm.

2-Found as : unicellular (motile or non-motile) or colony (motile or non-motile) or simple filament or branched (motile by flagella).

3-The Chlorophyta species found in the fresh water especially in iraqi water.

4-Cell walls usually have cellulose, as the main structural polysaccharide. **5-** Form the starch as food storage in the chloroplast.

6-Asexual reproduction , the simplest being by :

1- Fragmentation of colonies into two or more parts, each part becoming a new colony.

2-Forming of zoospores (are normally produced in vegetative cells).or aplanospores (non-flagellated).

7- Sexual reproduction in the Chlorophyceae may be : isogamus, anisogamous, or oogamous and conjugation .

1- O : Chlorellales

The algae in this order are non-motile , single cells or coenbium.

a- F : Chlorellaceae

ex: *Chlorella*

Unicells ,spherical , non-motile , cup-shaped chloroplast with pyrenoid.

b- F : Dictyoshaeriaceae

ex : *Dictyosphaerium*

Phytoplankton found as aggregation like a tree , cells are spherical with a cup-shaped chloroplast , The cells connected to each others with a gelatenious connections.

c- F : Scendesmaceae

ex : *Scendesmus*

Coenobium and non-motile, cells in the colony occur in multiples or two with four or eight cells being most common , the species differ mostly in the number and type of spines on the cells and the texture of the wall , every cell have a parietal shape chloroplast.

d- F : Hydrodictyaceae

ex : *Hydrodictyon*

The water net , is a free floating ,algae that forms colonies that are net-like with polygonal or hexagonal meshes. The net is formed by multinucleate elongated cells joined end to end. Each cell have a central vacuole and a reticulate chloroplast with pyrenoid.

Pediastrum

Coenobium colony , non-motile , parietal shape chloroplast.

2- O : Volvocales

In the volvocales the vegetative cells are flagellated and motile. The algae can be unicellular or multicellular. Almost of these organisms are found in fresh water.

There are two important families in this order :

a- F :Volvocaceae

ex: ***Volvox , Pandorina , Eudorina***

Colonial algae.

Pandorina	***Eudorina***
1-Spherical coenobium. **2-** Number of cells 16-32 cells. **3-**Cells large in size ,less in number. **4-**Reproductive by isogammy.	**1-**Spherical coenobium. **2-** Number of cells 32-64 cells. **3-**Cells large in number,less in size. **4-**Reproductive by anisogammy.

ex: ***Volvox***

Oval or spherical coenobium colonies, motile, 500-10000cells, oogamous reproduction each colony contain a large number of somatic cells and a smaller number of reproductive cells.

There are 4 types of cells found in *volvox* colony :

1-vegetative cells : spherical , has a single cup-shaped chloroplast with a basal pyrenoid.

2-conidial cells : daughter colonies enclosed in vesicles that expand into the interior of the colony.

3-male cells : have similar somatic structure, contain male initial cells (Anthridia).

4-female cells : have similar somatic structure, contain female initial cells (Oogonium).

Anthridia + **oogonium** ⟶ **Oospore (thick and spined walls).**

b- F : Chlamydomonadaceae

ex : *Chlamydomonas*

Unicellular , bi-flagellate , have a cup-shaped basal chloroplast with a central pyrenoid.

3- O : Ulothricales

a- F :Ulothricaceae

ex :*Ulothrix*

Uninculeate filamentous algae with a parietal chloroplast, found in a quiet or running fresh water on wet rocks or soil. The thallus consists of unbrached filaments of indefinite length , have a special basal cell. All of the cells except the basal one are capable of cell division and forming zoospores or gametes.

zoospores	**gametes**
1- large in size. **2-** less in number (2-16 cells). **3-** biflagellated or quadriflgellated according to species of algae (one or two pair).	**1-** small in size. **2-** high in number (16-64 cells). **3-** biflagellated (one pair).

Lab 6

Division: Chlorophyta
Class (I): Chlorophyceae
Order: Oedogoniales
Family: Oedogoniaceae
Genus: Oedogonium

Order: Cladophorales
Family: Cladophoraceae
Genus: *Cladophora, Pithophora*

Order: Zygnematales
Family(a): Zygnemataceae
Genus: *Zygnema, Spirogyra*
Family(b): Desmidaceae (Desmids)
Genus: *Cosmarium, Micrasterias, Closterium*

Class (II): Charophyceae
Order: Charales
Family: Characeae
Genus: *Chara*

Order: Oedogoniales

Family: Oedogoniaceae

1. The filamentous, freshwater, uninucleate algae
2. the production of motile reproductive cells with a whorl of flagella at one pole
3. Sexual reproduction is oogamous and asexual reproduction can be by zoospores or akinetes.
4. It has single family, the **Oedogoniaceae.**

Genus: *Oedogonium*

Identifying characters

1. Thallus multicellular, filamentous and unbranched.
2. Chloroplast is reticulate with pyrenoids at the intersections
3. Oogonia spherical, larger than the vegetative cell and bears one or more apical rings.
4. According to the position the filaments have three types of cells, (i) Basal
   (ii) Intercalary (iii) Apical.
5. The basal cell of the filament functions as a **hold fast**.
6. Asexual reproduction is by means of **zoospores or akinetes**.
7. Sexual reproduction is oogamous, female sex organ is **oogonium** and male sex organs are **antheridia**. Each antheridium produces two multiflagellate sperms.

On the basis of distribution of antheridia two species of Oedogonium are identified.

1. Macrandrous species, the antheridia are found on the filaments of normal size.
2. Nannandrous species, antheridia are produced on much reduced male filaments called dwarf males.

Order: Cladophorales

Family: Cladophoraceae

Identifying characters

1. Multinucleate filamentous algae reticulate chloroplast.
2. True branched filaments.
3. Pyrenoids at the intersections of the reticulum.

Cladophora	***Pithophora***
Branching opposite or dichotomously at acute angles	Branching alternate and often at right angle to the main filament.
Filaments without **akinetes.**	Filaments with **akinetes**.

Akinetes : is the direct modification of the vegetative cell which converted into a thick walled non-motile resting spore. Akinetes are not spores in the real sense , they are formed by the algae **to survive unfavorable conditions**.

Order: Zygnematales

Identifying characters

1. unicells or unbranched filaments without holdfasts
2. sexual reproduction by conjugation.

3. flagellated cells not produced.
4. There are three types of chloroplasts in the order:
   (1) spirally twisted bands extending the length of the cell as in *Spirogyra*.
   (2) two stellate chloroplasts next to each other as in *Zygnema*
   (3) an axial plate extending the length of the cell as in *Mougeotia*

Family(a): Zygnemataceae

The cells of the Zygnemataceae are cylindrical united permanently into unbranched filaments; cell wall without pores.

Genus: *Zygnema*

- simple filament.
- two stellate or star shape chloroplasts.

Genus: *Spirogyra*

- simple filament.
- spirally twisted chloroplasts.
- Asexual reproduction occurs by fragmentation of the filaments.

- sexual reproduction is by conjugation:
  (1) scalar conjugation: conjugation occurs between two filaments and being bound together by conjugation tube.
  (2) lateral conjugation: conjugation occurs between cells in the same filament.

Family(b): Desmidaceae (Desmids)

1. non filamentous.
2. cell walls with pores.
3. new semi cell formed in cell division.
4. The desmids are usually indicators of relatively unpolluted water, low in calcium and magnesium, with a slightly acidic pH.

Genus: *Cosmarium*

It has a central nucleus and two chloroplasts in each semi cell, each with a central pyrenoid

Genus: *Closterium*

Cells are curved shaped, variously bowed, there is one axial chloroplast per semi cell, each cell may have few to many pyrenoids, which can be axial or spread.

Genus: *Micrasterias*

Cells flattened with a deep median constriction; semicells with

Cell of *Spirogyra*

several lobes, those lobes with secondary lobes and lobules that appear as sharp teeth

Class (II): Charophyceae

Order: Charales

Family: Characeae

Identifying characters

1. The Thallus is macroscopic, branched and multicellular. The main axis is differentiated into nodes and internodes.
2. Both sex organs, the male sex organ is called '**globule**' and female organ '**nucule**', are present at one point on the node of the short lateral branch.

Genus: *Chara*

1. The plant body is calcified and commonly called "**stone worts**".
2. It is attached to bottom of pool by rhizoids.
3. The main axis consists of a series of alternating nodes and internodes.
4. Sexual reproduction in *Chara* is oogamous.
5. The male sex organ is a large, round bright yellow or red structure; it is **globule** (antheridium).
6. The female sex organ or oogonium is a large, oval body covered with multicellular envelope, it is known as **nucule**.
7. corona of oogonium (nucule) with five cells.

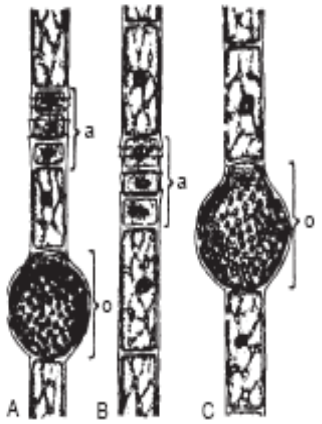


Fig. 1.11 Oedogonium. Distribution of sex organs in macrandrous sp. A, Macrandrous monoecious with the antheridia (*a*) and oogonia (*o*) on the same filament; B-C, Macrandrous dioecious with antheredia (*a*) on filament B and oogonia on filament C

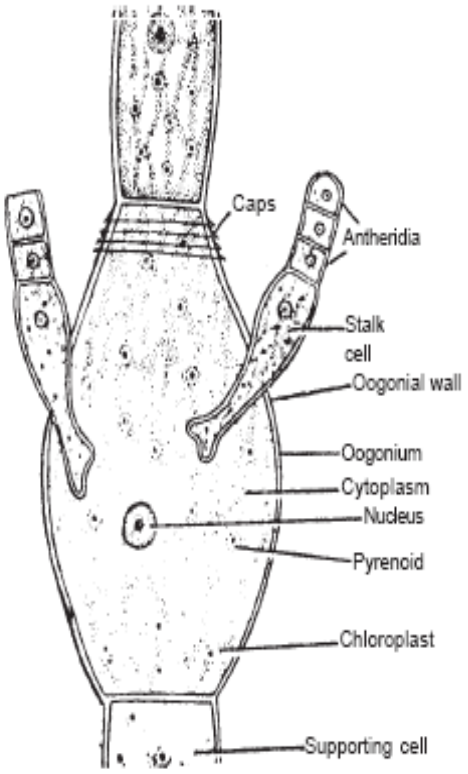


Fig. 1.12 Oedogonium. Oogonium with two dwarf males attached to it (Nannandrous species)

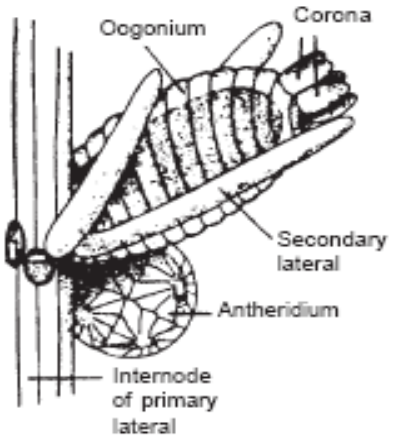


Fig. 1.15 Chara. Sex organs

Lab 7

Division: Euglenophyta
Class: Euglenophyceae
Order: Euglenales
Family: Euglenaceae
Genus: *Euglena, Phacus*

Division: Pyrrhophyta
Class: Dinophyceae
Order: Congualacales
Genus: *Ceratium*

Division: Euglenophyta (euglenoids):

1. Euglenoid flagellates occur in most freshwater habitats.
2. Euglenoids are characterized by chlorophylls (a, b).
3. A mesokaryotic nucleus.
4. Paramylon as the storage product in the cytoplasm.
5. Cells are surrounded by a pellicle.
6. The chloroplasts are usually discoid or plate-like with a central pyrenoid.
7. The eyespot (**stigma**) is in the anterior part of the cell.
8. Flagella with fibrillar hairs in one row.
9. They have a number of modes of nutrition: **Autotrophic**, **Heterotrophic**.
10. No sexual reproduction.

Order: Euglenales

Two flagella, only one of which emerges from the canal; no special ingestion organelle

Euglena

Identifying characters

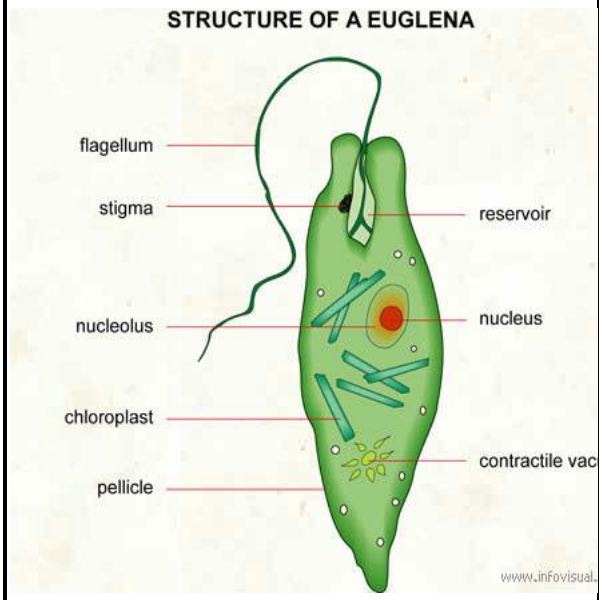
1. unicellular algae with different size and forms according to the species.
2. Storage food is paramylon that occurs outside the chloroplast.
3. Euglena spindle shaped cell.

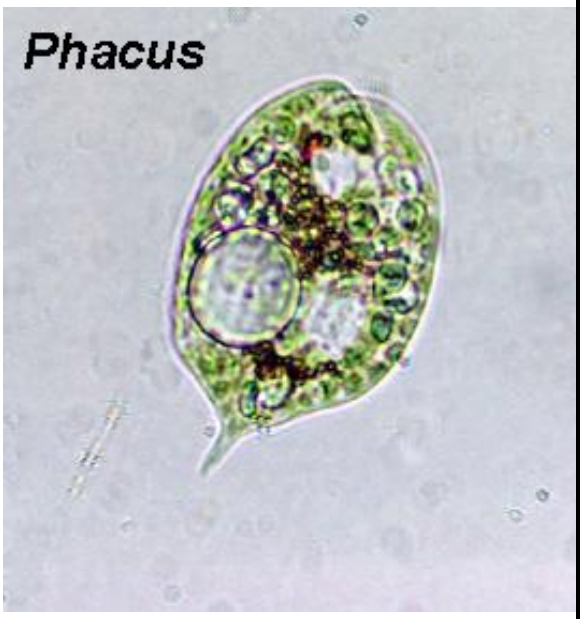
4. The chloroplasts are vary in form among the different species and genera (They may be small, simple disc; large plate like; or ribbon like).
5. The nucleus present in the center or posterior of the cell.

Phacus

1. The cell is rigid and ovate in front view with a short caudal process, clearly compressed and more or less twisted.
2. The periplast is usually ornamented with short spines.
3. The chloroplasts are numerous and discoid.
4. the paramylom bodies are one or two and large ring-shaped.

Euglena	***Phacus***
flexible pellicle, elongated shape	rigid pellicle, flattened shape





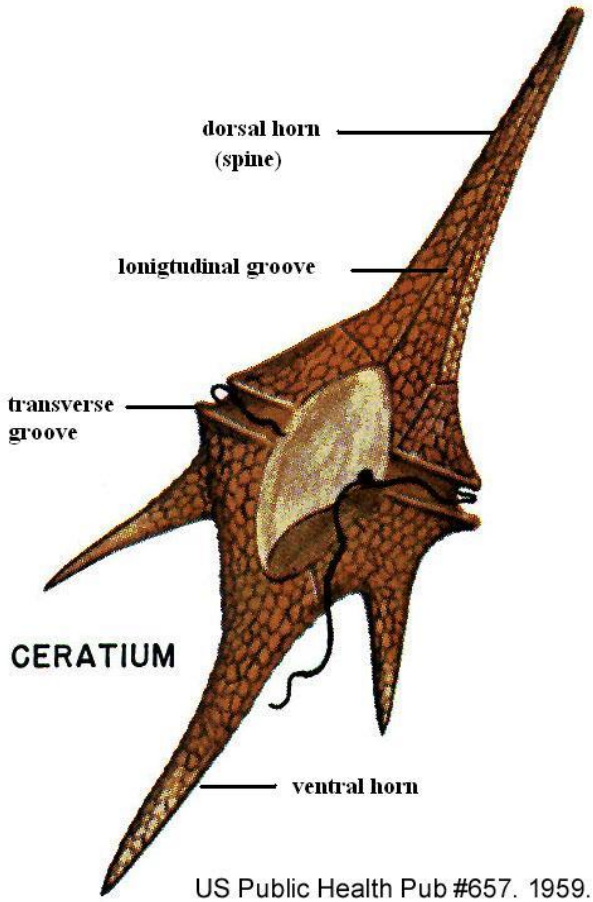
Division: Pyrrhophyta

1. Dinoflagelates are found in both marine and fresh water environments.
2. Mesokaryotic nucleus.
3. Most have plastids with chlorophyll a, c with peridinin.
4. Motile, unicellular flagellate algae.
5. Cells with an epicone and hypocone separated by a girdle, relatively thick theca.
6. Presence of yellowish-green to golden-brown plastids
7. Absence of cell walls.
8. With or without a gelatinous sheath
9. These dinoflagellates cause "red tides" that are lethal to fishes or invertebrates

Genus: *Ceratium*

1. More common in warmer water than in colder waters.
2. Unicellular forms with two flagella.

- ❖ One of these extends towards the posterior, called the longitudinal flagellum; acts as the steering wheel.
- ❖ While the other one of the flagella lies in a transverse groove called
- ❖ or the transverse flagellum, which divides the wall into a hypocone and an epicone.



US Public Health Pub #657. 1959.

Lab 8

Kingdom: Metaphyta (Monera)

Division: Xanthophyta

Class: Xanthophyceae

Order: Vaucheriales

Family: Vaucheriaceae

Genus: *Vaucheria geminate , V. sessilis*

Division : Chrysophyta

Class: Chrysophyceae

Order: Dinophyciales

Family: Dinophyceae

Genus: *Dinobryon*

D: Xanthophyta

1. Members of this group are photosynthetic organisms which live primarily in freshwater, marine waters, in damp soil, or on tree trunks.
2. Xanthophyta have **chlorophyll c**. This gives them a characteristic yellowish-green color, as opposed to the golden color or their relatives,
3. Most are flagellated unicells, but many are colonial.
4. There are also filamentous forms, which produce long chains of cells, and there are **coenocytic** forms , such as the water-felt *Vaucheria*. These coenocytes are tubular multinucleated filaments with no internal partitioning into cells.
5. Sexual reproduction is oogamous Most reproduction is asexual, and this is accomplished by a wide variety of means, including fragmentation of filaments, but often involving the production of some kind of spore. Spores may be flagellated and free-swimming

(**zoospores**), or they may be non-flagellated (**aplanospores**). Spores are formed internally, being released by rupture of the old cell wall.

6. The storage food usually as oil (fat) or **leucosin.**

Ex: Vaucheria

It is Genus of yellow-green algae. It is characterized by oil food reserves and tubular branches that have multiple nuclei and lack cross-walls except in association with reproductive organs or an injury. Vaucheria reproduce both asexually and sexually. The spherical female sex organ and the slender, hook-shaped male sex organ are usually produced on branches close to each other. After fertilization, the zygote may enter a resting phase for several weeks before developing into a new plant. Though most species occur in freshwater or are terrestrial, some are marine and others live in ice.

V. sessile	V. geminate
The reproductive organs are sessile on filament.	The reproductive organs are carried on branches
It's Have single oogonium and the antheridium either single or double.	Have 4 oogonia and single antheridium.

Division Chrysophyta

1. Chrysophytes, or golden algae, are common microscopic chromists in fresh water.
2. Some species are colorless, but the vast majority is photosynthetic. As such, they are particularly important in lakes, where they may be the primary source of food for zooplankton.
3. They are not considered truly autotrophic by some biologists because nearly all chrysophytes become facultatively heterotrophic in the absence of adequate light, or in the presence of plentiful dissolved food. When this occurs, the chrysoplast atrophies and the alga may turn predator, feeding on bacteria or diatoms.
4. Discoid chromoplast

Dinobryon

1. Freshwater genus, in which the individual cells are surrounded by vase-shaped **loricae**, composed of chitin fibrils and other polysaccharides.
2. The colonies grow as branched or unbranched chains.
3. Longitudinal fission is the characteristic form of reproduction in these unicellular flagellates.

Lab 9

Kingdom: Metaphyta

Division: Bacillariophyta

Class: Bacillariophyceae

Order: Pennales

Ex: Diatoma , Cymbella

Order : Centrales

Ex: Cyclotella , Melosura

Division : Phaeophyta (brown algae)

Class: Isogenerate

Order: Ectocarpales

Family: Ectocarpaceae

Genus: Ectocarpus

Notice: sporophyte with plurilocular and unilocular sporangium.

Gametophyte with plurilocular gametangium.

Class: Cyclospora

O: Fucales

F: Fucaceae

Ex: *Fucus*

Notice: c.s through receptacle with: Female Conceptacle, Male conceptacle, Monoeicious conceptacle.

Class: Phaeophyceae

O: Laminariales

F: Laminariaceae , Ex: Laminaria

Bacillariophyta:

1. Diatom cells are contained within a unique silicate (silicic acid) cell wall comprising two separate valves (or shells). and their two valves typically overlap one over the other like the two halves of a petri dish. the upper valve called epitheca and the lower valve called hypotheca; connecting together by connecting band.
2. This siliceous wall can be highly patterned with a variety of pores, ribs, minute spines, marginal ridges and elevations; all of which can be utilized to delineate genera and species.
3. Major pigments of diatoms are chlorophylls a and c, beta-carotene fucoxanthin, diatoxanthin and diadinoxanthin.

O. Pennales	**O. Centrales**
1. pennate diatoms	centric diatoms
2. Bilateral symmetry	Radial symmetry
3. They are more common in fresh water.	Less number than pennales found in salt water.
4. Many groups possess a raphe-these are motile; some have a pseudoraphe.	Absence
5. Isogamous sexual rep.	Oogamous sexual rep.

Phaeophyta

Prominent macrophytic algae in freshwater and marine benthic systems with high diversity (1500 species)

1. Annual and perennial forms, some up to 15 years old
2. Cell walls contain three components: cellulose (structural support), alginic acid, sulfated polysaccharids
3. Alginates are located in intercellular matrix and provide flexibility of the thallus and prevent desiccation

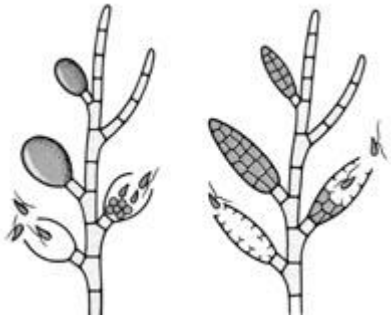
4. Pigments: Chl. a, c, b-carotene, violaxanthin, fucoxanthin
5. Storage product: laminaran, mannitol, glycerol
6. Anti-freeze effect of mannitol and glycerol important for kelps in temperate and polar regions
7. Gametes can be isogamous, anisogamous, and oogamous.
8. algin and fucoidin are important secondary metabolites and are used in the manufacture of beer, toothpaste, ice cream, paint, shaving cream, medicine and soaps.

Ectocarpus:

1. Common in the colder seas. large filament.
2. It is one of the primitive brown algae with an isomorphic life cycle, i.e. the sporophyte (2n) and gametophyte (1n) generations are identical in appearance.
3. Sporophyte produce spores in :

- Unilocular sporangia only occur on sporophytes ovoid like shape with one cell 2n , firstly meioses occur then mitosis to produce 32-64 nuclei (1n), each nuclei surrounded by its protoplast to develop zoospores, released to yield new haploid plant.

- Plurilocular sporangia: conoidal shape or corn cob- like shape consist of many cubic cells, each one produce one zoospore diploid which yield diploid plant.



Unilocular plurilocular

4. Gametophytes produce gametes in plurilocular gametangia
5. Plurilocula gametangia („sporangia“) sometimes also produce asexual zoospores, which into plant similar to parent plant .

Fucus:

1. One of the marine macro algae.
2. Life Cycle of Fucus: A gametophyte is lacking; the sporophyte produces gametangia in conceptacles on its blades, which release eggs and sperms; the zygote develops into a new sporophyte.
3. No asexual reproduction in Fucus.
4. Oogamous sexual reproduction.
5. The thallus is perennial with an irregular or disc-shaped holdfast .
6. The erect portion of the thallus is dichotomously branched, flattened and with a distinct midrib.
7. Gas-filled pneumatocysts (air-vesicles) are present in pairs in some species, one on either side of the midrib.
8. The erect portion of the thallus bears cryptostomata and caecostomata (sterile surface cavities). The base of the thallus is stipe-like due to abrasion of the tissue lateral to the midrib and it is attached to the rock by a holdfast.
9. The gametangia develop in conceptacles embedded in receptacles in the apices of the final branches.

- Male conceptacle
- Female conceptacle
- Monoecious conceptacle.

Laminaria:

- Common name "kelp.
- Life Cycle of Laminaria: sporophye is prominent sea kelp, but gametophyte is microscopically small; unilocular sporangia occur on the surface of the sporophyte's blade.

Lab 10

Division: Rhodophyta (Red algae)
Class: Rhodophyaceae
Sub class: Floridophysidae
Order: Ceramiales
Family: Ceramiaceae
Genus: *Polysiphonia*

Rhodophyta

Identifying characters

1. The Thallus is heterotrichus, filamentous and polysiphonous.
2. It is contain chlorophyll *a*; phycobiliproteins; storage product is floridean starch.
3. No flagellated cells.
4. Sexual reproduction is Oogamous. Male sex organ is called spermatangium and female sex organ is called carpogonium.
5. Haploid tetraspores are produced on tetrasporophyte.
6. It is used in the different food products made with derivatives (carrageenan, agar, and edible algae)

Polysiphonia

1. It is marine red alga.
2. Thallus is brownish red to dark purple red in colour.
3. Thallus is filamentous branched and heterotrichous.
4. There is one axial siphon called central siphon, surround by 4-20 pericentral siphons.
5. The short branches (trichoblasts) are monosiphonous and dichotomously branched and bear sex organs.
6. Each cell is uninucleate with many discoid chromatophores arranged in the periphery of the cytoplasm. Cells are connected with each other by cytoplasmic pit connections.
7. Polysiphonia shows diplobiontic life cycle and is triphasic. It shows two diploid and one haploid individual. The individual are:
    - Gametophyte: free living haploid male and female plants having haploid sex organs spermatangia and carpogonia.

- Carposporophyte: diploid and dependent on gametophyte and produces diploid carpospores.
- Tetrasporophyte: diploid free living and produces haploid tetraspores.

Spermtangia

1. Male thallus bears spermatangia, which are closely packed and form a compact cone shaped structure on the short monosiphonous branches called
   Male trichoblasts.
2. Spermatangia are spherical or oblong unicellular structures
3. It has a large nucleus and colourless cytoplasm.
4. The spermatangial wall is thick and differentiated into 3 layers.
5. Spermatangium produces a single male gamete called spermatium.
6. Spermatium is unicellular, spherical, non-motile structure and are liberated through a slit in the spermatangial wall.

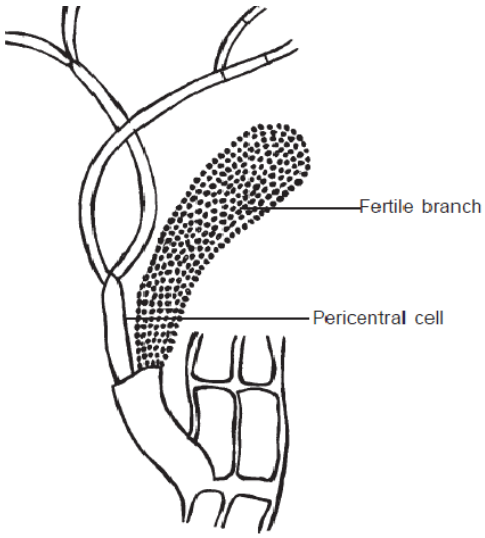


Fig. 1.21 Spermatangium

Tetrasporangia

1. Tetrasporangia are found in longitudinal series and develop from the pericentral cells.
2. Tetrasporangia are small spherical bodies borne on short one celled stalk and are externally covered by two cover cells
3. Each tetrasporangium possesses four tetrahedrally arranged uninucleate haploid tetraspores.
4. The tetraspores germinate to give rise to gametophyte.

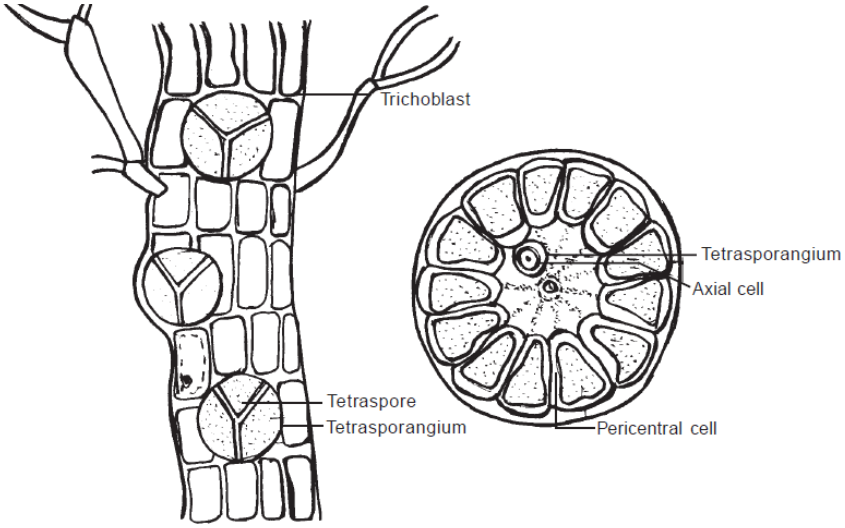


Fig. 1.22 Tetrasporangia

Cystocarp

1. It is an oval or vase shaped structure attached to the gametphytic filament
   (haploid). It opens to the exterior by a pore called ostiole.
2. Wall of the cystocarp is called pericarp and is made up of single layer of cells, which are haploid.
3. Cystocarp consists of a placental or fusion cell at the base.
4. From the placental cell many diploid filaments called gonimoblast filaments arise, the terminal cells of which bear carposporangia, each of which bears a single diploid carpospore.
5. Carpospore on germination produces diploid tetrasporophyte.